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IN THE

Supreme Court of the United States

OCTOBER TERM, 1938

No. 127

MACKAY RADIO AND TELEGRAPH COMPANY, INC.,

Petitioner,

vs.

RADIO CORPORATION OF AMERICA,

Respondent.

BRIEF FOR RESPONDENT

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INDEX

CHART

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The sole issue before this Court is the correctness of the decision of the Circuit Court of Appeals for the Second Circuit (MANTON, LEARNED HAND, and SWAN, *JJ.*) holding valid and infringed claims 15 and 16 of Carter patent No. 1,974,387, granted to respondent September 18, 1934, for an antenna structure for use in radio communication. There has been no other litigation on the patent, and no new or disputed questions of law are raised. The trial court (CAMPBELL, *J.*) construed the patent to be so limited by its disclosure as not to be infringed; the appellate court construed the patent differently and found infringement.

Opinions of the Courts Below

The opinion of the District Court for the Eastern District of New York is reported in 16 Fed. Supp. 610 (II, 1133).[1] In this opinion and in the testimony, the Carter

[1]References to the record herein are by volume and page. Thus "II, 1133" means "Volume II of the record, page 1133".

patent that is now before this Court is referred to as the "third Carter patent".

The opinion of the Court of Appeals is found in 96 Fed. (2d) 587 (II, 1167).

Jurisdiction

Jurisdiction of the Court is not questioned by respondent.

Reply to Petitioner's "Statement of the Case"

Petitioner's "Statement of the Case" (pp. 3-6 of its brief) deals to a considerable extent with matters outside the record, and having no bearing on the issues. Nevertheless, as petitioner seems to think these matters of importance, we make the following comments on petitioner's statement, numbering our paragraphs to correspond to those of petitioner.

1. There is nothing in the record to support petitioner's statement that "petitioner, and its associated companies, constitute the only competition to the world-wide public radio telegraph service operations of respondent and its subsidiary". Respondent denies this statement.

2. There is no pleading or evidence in this record referring directly or indirectly to what petitioner calls "the radio patent pool". The invention set forth in the patent in suit was a product of experimental research conducted by respondent's engineers. The patent is and always has been owned by the plaintiff-respondent.

3. The statements advanced by petitioner in paragraph 3 of its "Statement of the Case", referring to respondent's relations with third parties, are entirely foreign to the pleadings and evidence and are merely petitioner's conclu-

sions, misleading, incomplete, and wholly immaterial to the issues of this case.

4. The present action is an effort of respondent to enforce a valid patent against a direct infringer. That such enforcement may affect the operations of a competitor is a normal consequence of enforcing any patent. Petitioner was engaged in its "world-wide" radio activities before it commenced the infringement complained of, and there is nothing (except petitioner's argument in its petition for certiorari) to indicate that it will be eliminated from such communication if it has to discontinue this infringement.

5. Petitioner's assertion that respondent "completely altered the statement and claim" of the pending Carter application for the patent in suit to include petitioner's antenna structures after receiving particulars of petitioner's structure and operation is untrue. The contrary is fully shown at pages 37-41, below.

7. The trial court's findings that petitioner's antennas differed "radically" from those described and claimed in the patent here in suit, and that the patent was improperly broadened by amendment, were *conclusions* based upon that court's *interpretation* of the patent and the application therefor as originally filed. *Upon the same documentary evidence*, the Court of Appeals reached different interpretations and conclusions. This Court will have to base its decision upon the same *documents*, and will find *no conflicting fact testimony whatever* bearing upon the conclusions referred to.

8. Of course, the stipulation (II, 1158) that the opinion of the trial court be accepted as its findings of fact

and conclusions of law involved no concession on respondent's part either as to the correctness or completeness of the findings and conclusions. The stipulation was entered into merely for *petitioner's* convenience and at its request so that it would not have to comply with the trial court's request (II, 1157) that proposed findings of fact and conclusions of law be submitted "in accordance with" the opinion.

10. The Court of Appeals did not reverse *any* "essential finding of fact" made by the trial court on conflicting evidence. It merely reached a different *interpretation* of the disclosure of the Carter patent and of the application therefor as originally filed, about which there was no conflict of testimony, and therefore reversed the *conclusions* of the trial court based upon different *interpretations*.

The Subject-Matter Involved

While we assume that, in a case like this, coming to this Court with a unanimous decision of the Court of Appeals below, and no conflicting appellate decisions, the burden is heavily on petitioner to establish reversible error, and that it would probably be sufficient if we should merely answer the points argued by petitioner, nevertheless we feel that, in any case involving the validity and infringement of a patent, the Court should have before it a more complete statement of the subject-matter of the patent, and particularly its relation to the prior and present art, than has been given in petitioner's brief.

As was said by the then Chief Justice of this Court in *Eibel Process Co.* v. *Minnesota, etc., Paper Co.*, 261 U. S. 45, at page 63:

> "In administering the patent law the court first looks into the art to find what the real merit of the al-

leged discovery or invention is and whether it has advanced the art substantially. If it has done so, then the court is liberal in its construction of the patent to secure to the inventor the reward he deserves."

Directional Signaling and Radio Beams

Directive radio transmission is of great commercial importance in "point-to-point" communication,—*i. e.*, where messages are to be exchanged between two or more fixed stations, such, for example, as New York and London. The antenna of a radio *broadcasting* station is designed to send out radio signals equally in every direction (I, 76-77), since it is desired that all of the surrounding public hear the broadcast. But in "point-to-point" radio communication, involving messages for a single receiver, it is highly desirable to concentrate the radiation into a "beam", as it is called, projecting the signal-carrying energy principally in the direction of the desired receiving station, because energy radiated in other directions is not only lost, but tends to disturb and interfere with communication between other stations.

One may visualize the difference between a non-directive broadcasting and a directive communication antenna by comparing their distribution of signal-carrying energy with distribution of light from a street lamp, adapted to illuminate everything around it, and from a searchlight, or automobile headlight, adapted to concentrate most of the light into a beam extending in one general direction only.

Directional signaling is fully discussed by respondent's expert Hogan at I, 76-78 and 80-83, and is well explained in the opinion of the Court of Appeals in this case at II, 1167-1168.

Prior Commercial Forms of Directive Antennas

The problem of directive wireless signaling was one of the oldest in the art.[2] The patents and publications cited by petitioner show that inventors and scientists of note have worked on this particular problem from the earliest days of wireless on down to the present. With the coming into general use of short radio waves for long distance communication about 1923, there was increased activity in such research and active world-wide study of the problem of directive antennas for point-to-point communication. There is no dispute about these points. The activity here and abroad is recited at some length in the historical testimony of respondent's witness Hansell at I, 32-48.

(1) *Early Research on Short-Wave Directional Antennas:*

Directivity is more easily secured where radio communication is carried on by comparatively short waves, *e. g.*, less than 100 meters in length. In the year 1923, when the advantages of the use of such short waves for long distance communication were becoming more apparent to the art, respondent's engineers began a research into the possibilities of directive short wave antennas. This is summarized by Hansell, beginning at I, 32. For about a year, experimental work with such antennas was carried on by respondent's engineers; the work was then taken over by the General Electric Company, where it was carried on for two years or more under such well known radio engineers as Alexanderson, Rice, Kellogg, and Baker (I, 35). Many types of directive antenna were built and tried out; but "substantially no commercial use" appears ever to have been made of any of the antennas thus developed

[2]See, for example, the Brown British patent of 1899 (Defendant's Exhibit AA, II, 839).

(I, 34-35). This experimental work was discontinued in 1926, largely because of the great success which the British Marconi Company realized in that year with its "beam system" directive antenna, working between Canada and England. In 1926 and 1927, respondent purchased two of the Marconi beam antennas, installing one of them at Rocky Point, New York, for transmitting signals to England (I, 35-36) and the other at Riverhead, New York, for reception of signals.

(2) *The Marconi Beam and Telephone Company Antennas:*

The Marconi beam antenna is made up of a complex network, or curtain, composed of sixty-four radiating wires, each made up in a considerable number of sections and suspended vertically from a system of structural steel towers 300 feet high, with cross arms 75 feet long at their tops.[3] In practice it was found very difficult to adjust this antenna and to keep it in adjustment. Wind and ice frequently stripped off the wires; maintenance was very expensive. The initial cost of these Marconi beam antennas which were erected at Rocky Point was between $100,000 and $175,000 each. The antennas were highly directive, and very efficient for concentrating the radiated energy in the direction for which it was intended. (See Hansell's testimony I, 36-39, 44-45.) Here again there is no denial or conflict of testimony.

Because of the difficulty and expense of maintenance, and the high initial and repair costs of the Marconi beam antenna, respondent's engineers again attacked the problem of producing a better form of directive short-wave antenna. This work was carried out by a group of radio engineers working for respondent at Rocky Point, New

[3]See II, 532-534, for details and appearance of the Marconi antenna.

York, under the direction of the witness Hansell. One of these engineers was Lindenblad, who will be referred to later; another was Carter, the patentee of the patent here involved.

Meanwhile,[4] the American Telephone and Telegraph Company was also working intensively on development of short-wave directive antennas. After much research, that company erected, in 1929, its Lawrenceville, New Jersey, station for transatlantic communication. The antenna employed was of the suspended network type, involving high structural steel towers and great expense. (I, 47-48; see also Bruce, I, 377.) Illustrations of that antenna are in the record at II, 609-611, 618-620.

(3) *The Results of Respondent's Research:*

As a result of its research work, respondent's engineers between 1927 and 1930 developed and built four types of directive antennas, referred to in the record respectively as models A, B, C, and D. The patent here in suit discloses and covers model D, the last of this series of developments.

The model A antenna, like the Marconi beam, employed a network of short radiating wires vertically suspended in a curtain-like arrangement.[5] The model A was cheaper than the Marconi antenna, costing about $80,000 to erect. However, it was considerably less directive than the Marconi antenna, and it had the same objections, in that it was hard to adjust and keep adjusted, and the network of wires was frequently injured by wind or ice. Consequently,

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[4]Meanwhile also, in England, Germany and France, independent research developed other types of directive antennas. These are described in Hansell's testimony (I, 46-47). See the illustration of one of the actual antennas at II, 608.

[5]Illustrations and diagrams of this antenna are in the record at II, 535, 536, 555.

maintenance costs were high. Nevertheless, thirty-eight model A antennas were built and put into service by respondent. (I, 39-41, 45.)

Respondent's engineers next tried out a type of antenna that was called an "expanding wire antenna" which comprised an expanding extension of a two-wire transmission line, the wires starting close together at one end and progressively increasing in spacing to the other end. This was the antenna of Figure 1 of the Lindenblad patent No. 1,927,522 (II, 486). No commercial model resulted although, in several instances, the experimental antennas were used to handle commercial traffic. This diverging wire antenna was not as directive as the model A. (I, 41-42.)

Models B and C, which were the next development, were of quite a different type. Each of these models consisted of one or more pairs of long, *parallel,* horizontally supported wires. Units of these types cost, respectively, $30,000 and $48,000 per antenna. These models B and C were more directive than model A, but still were less directive than the Marconi beam antenna. However, they were commercially successful, and upwards of thirty of these two types were placed in commercial service by respondent or its subsidiary. (I, 41-43, 45.) For a while, they looked like the final solution of the short-wave directive antenna problem from a practical point of view.

But meanwhile, Carter was working on another antenna, the model D, which when tried out was found to be superior in economy of erection and maintenance to any of the directive antennas theretofore used. That is the antenna of the patent in suit. By suitably combining the V units as Carter designed them, an antenna is obtained which gives, at a cost of about $5,000, a signal concentration forty times that of a standard comparison unit and equal to that

of a Marconi beam antenna, which cost between $100,000 and $175,000. (I, 45.)

Success of the Carter Model D Antenna That is Covered by the Patent in Suit

Respondent's Exhibit 47 (II, 713) is a letter from Hansell, who was in charge of this directive antenna work, dated May 7, 1930, transmitting Carter's "report on the results of tests recently made on a new type of directive transmitting antenna which he devised." The report itself is dated May 6, 1930, and is Respondent's Exhibit 44 (II, 699-708). Respondent's Exhibit 43 contains a complete description of the new antenna, dated January 4, 1930, and signed by Carter (II, 654-661). The most casual inspection of these exhibits shows that the antenna referred to therein is the antenna of the Carter patent in suit. Indeed, the drawings of the patent appear to have been taken from the Carter memorandum of January 4. (See pages 1 to 5 of the memorandum.)

Hansell's letter, Exhibit 47, after calling attention to the fact that this new type of antenna seemed to be a decided improvement (over models B and C) due to its improved directivity and greater simplicity and economy of structure, suggested

> "that consideration be given to substituting the new antenna for the original harmonic types in the present construction programs for Rocky Point, New Brunswick, Bolinas, Kahuku (Telephone) and other places",

and estimates a total saving to respondent, "if all the new transmitters now scheduled were equipped" with this new model D antenna, of at least $3,500,000.

The first of these model D antennas which went into commercial service was placed in Bolinas, California, in

1930. At the time of the trial, forty such antennas had been erected and placed in operation by respondent or its subsidiary. (I, 44.)

The Published Description of Carter's Antenna

A complete description of the structure, mode of erection, and operation of, and an elaborate mathematical analysis of the radiation from, the model D antenna were given in a paper read before the Institute of Radio Engineers in June of 1931 and published in its Proceedings in October, 1931. This paper is Plaintiff's Exhibit 20, and it is reproduced in full in the record at II, 538-607. *There can be no question but that this paper "contains sufficient information as to structure, arrangement, and adjustments to enable a radio engineer to construct and operate the antennas there described"* (I, 44). There is no dispute on this point in the testimony.

During the year following the publication of Carter's Institute of Radio Engineers paper, petitioner (which had previously carried on its "world-wide" communications with other types of antennas) erected the first of the eleven accused antennas at its Sayville, New York, station (I, 29). As appears from a mere inspection of the stipulated diagrams,[6] and as will be shown in detail below, these antenna structures of petitioner are *substantially identical with the model D antenna invented by Carter,* and described in the publication above referred to, previously erected and put into commercial service by respondent, and subsequently patented.

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[6]II, 510, 514, 518, 522, 525, 529.

The Carter Patent in Suit No. 1,974,387

The fundamental unit of the antenna of the Carter patent in suit, and of petitioner's antennas, is simple and easy to visualize. It involves structurally merely two long,[7] straight wires arranged in V form, having the wire length, wave length, and angle between the wires co-ordinated as directed in the patent. This simple structure will readily appear from an inspection of the insert opposite this page, comprising reproductions of Figure 4 of the Carter patent and of the stipulated diagram of petitioner's antenna No. 2 (original).

Carter's specification begins with the statement (II, 499) that it is known, that is to say that it is prior art so far as he is concerned, that when a single straight wire (antenna) is excited by a radio current so as to produce standing waves[8] on the wire, the wire being longer than the radio wave, the predominant radiation from that wire will go out into space in the very curious way indicated in Figure 1a of the patent. In this figure, the horizontal line 2 is the wire; the radiation goes out principally in the directions marked Y, Y, Y, Y, or rather not merely in those four

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[7]The term "long", as used herein and in the record, in connection with wires, means wires which are long *in relation to* the wave length used. Thus, a 600-foot wire is "short" if used with a wave length of 1,000 feet but "long" if used with a wave length of 100 feet.

[8]Radio engineers speak of two kinds of waves on an antenna wire: standing waves and traveling waves. If we take an extremely long wire and introduce radio waves, or, more properly, oscillating current of radio frequency, into one end of it, waves will travel down the wire, radiating their energy into space as they travel, until finally their energy is exhausted before they reach the end of the wire. These are called "traveling waves" (I, 95-96 and 111). If the antenna is somewhat shorter, the entire energy of the waves will not have been radiated when they reach the end of the wire and the waves will, when they reach the end, be reflected back along the wire, until finally a steady condition of things results, in which "standing waves" exist along the length of the radiating wire (I, 96-97).

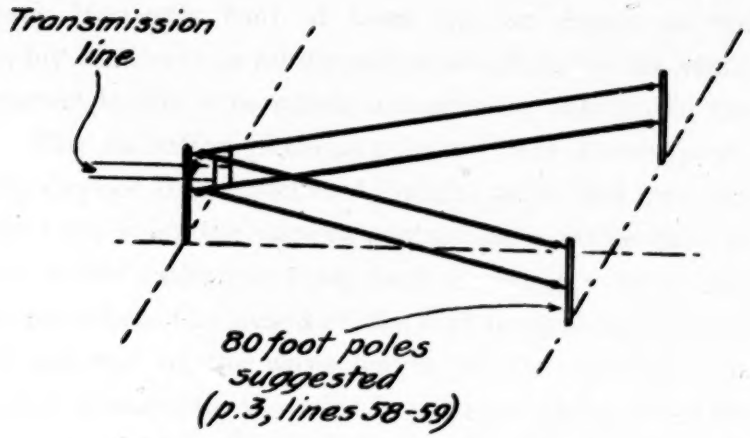
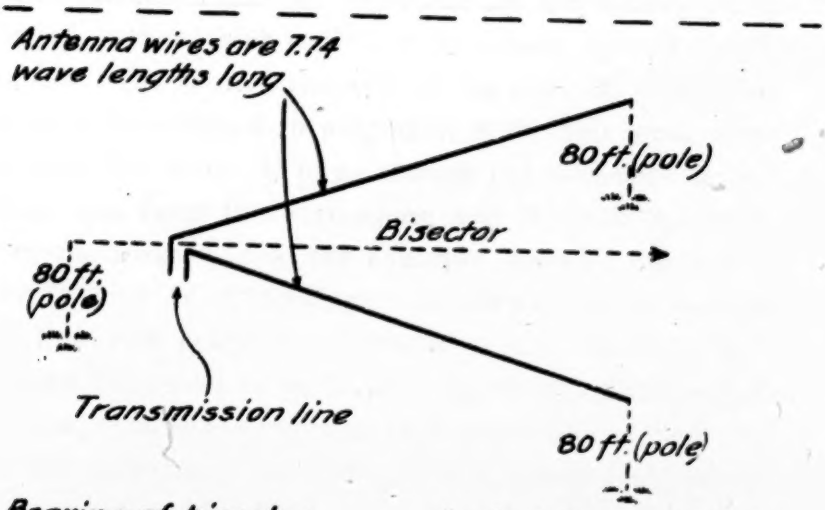


Fig. 4 of Carter Patent (single V)
(The extra V is an optional arrangement; p.3, lines 24-27)



Bearing of bisector is N. 49.75° E.; bearing of Vienna is N. 49.74° E. (II, 530)

Angle between bisector and each antenna wire is 17.5°; angle recommended by Carter is 17.8° for wires 7.74 wave lengths long (I, 139)

Petitioner's Antenna No. 2 (original)
Diagram annexed to plaintiff's Exhibit 10
(II, 522)

directions (for only four of them can be shown on the paper), but similarly in all directions which make the angle with respect to the wire which is marked α (alpha) in the figure. This radiation phenomenon had been known since the early days of the art, when Abraham published (in 1898 and 1901) his scientific papers containing a mathematical analysis of the radiation from such a single wire in the special case where the length of the wire is an *integral* multiple of one-half of the wave length of the current.[9] In Abraham's discussion, the wire is assumed to be "in free space", *i. e.*, so far removed from all other conductors (such as the earth) that the radiation travels uninterruptedly to infinite distances in the original directions.

The actual three-dimensional distribution of the predominant radiation may be visualized by comparison with a pair of rather thick-walled megaphones placed small end to small end around the wire at the point at which the radiation is considered to originate, with their axes coinciding with the wire. It is as though the principal radiation went out from the wire along and through the thick walls of the megaphones; for example, between the heavy line 6 in Figure 1a of the Carter patent and the unmarked dotted line just below it. Naturally, any receiving station which happened to lie in any one of the directions Y would receive more energy than stations in other directions.

But there are many such directions Y, actually an infinite number: on each side of the wire, above it, below it, in fact all the way around it. Therefore a large part of the radiated signal energy is wasted by such an arrangement, because much of the energy goes out in directions that do not include receiving stations with which it is desired to communicate.

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[9]Petitioner's Exhibit V, II, 761-784.

The first of the antennas of the Carter patent, the one shown in Figure 2b, reduces this waste enormously. It is a very simple structure, consisting of two wires, A and B, which in practice may be strung on telegraph poles 80 feet high (patent, p. 3, line 58, II, 501) and are connected by the wires 10 with the source of energy at the radio station. The two wires A and B spread out from each other in such a way that the angle between them is twice the angle *alpha*, which is the angle between the wire 2 of Figure 1a and any one of the lines Y. The two wires A and B are connected respectively to the two terminals of the radio supply circuit, a simple matter that results in the condition which is referred to in the record by the rather occult term "phase opposition" (I, 113-114).[10]

The result of Carter's arrangement is a very powerful signal transmission in both directions along the line X-X of Figure 2b. As Kelley, petitioner's expert witness, puts it (I, 216-217):

> "The third Carter patent[11] arranges the wires of the V in such a manner that these principal lobes of radiation, of which I just spoke, on the inside, so to speak, of one wire, with the principal lobe in the inside of the other wire, so it all will come together when the angle between the principal lobe of radiation and the wire is equal to the angle to the bisector of the two wires, in other words, that *these lobes will now*

[10]Connecting the wires in "phase opposition" merely means that the wires are connected to the opposite poles of the generator. The result is that when a given point on one wire has, at a given instant, a positive electric charge, the corresponding point on the other wire has a negative charge. It is admitted that petitioner's antenna wires are excited "in phase opposition whereby standing waves of opposite instantaneous polarity are formed on the conductors throughout their length",—as described in Carter's claim 15.

[11]The "third Carter patent" is the one that is before this Court. The first and second Carter patents related to another subject,—impedance matching.

combine exactly in the plane of the wire and along the direction of the bisector." [12]

But curiously enough, this is not the only result. In a manner which is too complex for easy explanation, the other portions of the "cones" or "tubes" of radiation and also the smaller cones, appearing in Figure 1b as "ears", or "lobes" as they are called, substantially disappear, canceling each other out. Much of the energy that went into them in the case of the single wire is, in the V arrangement of the two wires diverging at substantially the angle two-*alpha*, radiated as a part of the beam that has its axis on the bisector of the angle of the V antenna. This affords a maximum concentration of radio energy along the line X-X.[13]

Figures 2a and 2c have to do with details of the supply of energy, tuning, etc. Figure 3 is a plot of the distribution of energy radiating from the antenna shown in Figure 2b, showing a very strong preference in the direction X-X, front and rear,—a strong two-way ("bidirectional") beam.

Figure 4 introduces another feature, one which is not used by petitioner, consisting of the additional wires A′ and B′ mounted below the main antenna wires and parallel with them.

A further improvement appears in Figure 5. We have said, and it appears from Figure 3, that the antenna of Figure 2b radiates energy in both of the directions X-X; that is to say, both forward and backward. It is usually desirable that the radiation should be concentrated in one direction,—*i. e.*, that the antenna should be made "unidirectional". This is accomplished by the use of an addi-

[12]Emphasis herein is ours unless otherwise stated.

[13]See I, 122, 455; also, compare Figures 1b and 3 of the Carter patent.

tional pair of wires, a, b, etc., mounted behind the main wires A, B, etc., the additional wires being located "an odd number of quarter wave lengths" behind the main wires, and being so fed with current that the standing waves of current which they carry have a certain definite phase relation with the standing waves in the main antenna wires A, B, as set forth in the last column of page 3 of the patent.

The effect of all this is to reverse the radiation which is shown in Figure 3 as going out to the left along the line X-X, to turn it around, and to superimpose it on the radiation which is going out to the right. The distribution of radiated wave energy would then appear, in plan view,—*i. e.*, to one looking down from above,—as it appears in the plot, Figure 6.[14]

Figure 7 is a corresponding plot of the wave energy in the "vertical plane"; that is to say, it shows how much of the energy goes out horizontally as compared to directions at angles to the horizontal. This vertical distribution, we remark in passing, is, at a distance from the antenna, somewhat altered by the well-known earth reflection, or "ground effect", referred to in the legend on Figure 7. That will be discussed in detail later.

There is nothing mysterious in these plots; they graphically represent the "beams" of radiated energy from an antenna *per se*,—*i. e.*, when ground effect is neglected. They also indicate the energy quantitatively, for if a line such as the line marked 10° be drawn on the plot, as it is drawn on Figure 7, the distance from the origin of the line to the point where it crosses the cigar-shaped boundary

[14]Of course, Figure 6 is not drawn to the same scale as Figure 3, for the use of a double V, to secure unidirective action, approximately doubles the radiation in the desired direction as compared to a single V (I, 125).

curve of energy distribution represents the relative amount of energy radiated in that particular direction. Thus it appears from Figure 7 that substantially no energy is radiated at an angle of 20° upward, but that a good deal of energy is radiated at an angle of 10° upward, whereas it appears from Figure 6 that very little energy is radiated horizontally at 10° to the left of the preferred direction, that is, the direction of the line pointing to the receiving station, and that no substantial amount of energy is radiated more than 5° to the right or to the left of that line (I, 79-80).

The remaining figures of the patent, except Figure 12, relate to refinements which are not here involved; we see no need to discuss them.

Figure 12 of the patent is a graph by means of which, having chosen the length of the radiating wires (to suit the amount of ground available or otherwise) and the wave length to be used, one can readily determine the proper angle between the wires and set up a V antenna to get maximum concentration of radiation along the bisector of the angle of the V. From this it appears that the angle gets smaller as the length of the wire in terms of wave length increases, being about 72° at two wave lengths, 50° at four wave lengths, 42° at six wave lengths, 36° at eight wave lengths, etc.

The Carter patent describes single-V and double-V, long wire antennas, carrying standing waves, and teaches, for all finite lengths of wire, the optimum relation of the angle between the wires, the lengths of wires, and the wave length employed, for obtaining maximum radiation along the bisector of the angle between the wires.

The two claims in suit define Carter's antenna structure and set forth the optimum relation (which results in maxi-

mum radiation along the bisector of the angle between two antenna wires arranged in V-shape and fed in phase opposition) of the *wire length, wave length,* and *angle between wires.* This relation is defined by a mathematical formula involving the three variable quantities. Knowing any two, the other is determined by the formula. It holds good for any finite wire length.

Petitioner's V Antennas

In considering what had been *used* in the prior art for directional antennas, and by way of showing that petitioner did not follow the prior art, and why not, the testimony of its own chief engineer, Mr. Pratt, is most enlightening. *Mr. Pratt was the engineer entirely responsible for the design and construction of petitioner's V antennas* (I, 204). Previously, he had been a radio engineer for the Marconi Wireless Telegraph Company of America and had superintended construction of some of its antennas (I, 200). Then he was an expert radio aide in the Navy Department. As such he "was in charge of engineering and maintenance and design of all of the high power radio stations operated by the Navy Department." After that he was in charge of "engineering work for the Federal Telegraph Company and built a system for them" (I, 200). That company "operated a commercial radio station system, which extended up and down the Pacific Coast, connecting the various cities there by radio telegraph for commercial service." Then he built "a system of communication for the Western Air Express, between Utah and California." After that he was "in charge of development of radio aids for air navigation under the Commerce Department, Bureau of Standards," until he became chief engineer of petitioner in 1928. He testified (I, 201):

"During this time, particularly while I was in charge of the radio work for the United States Navy, I had many occasions to inspect radio transmitting and receiving stations. *I examined several hundred radio transmitters during this time.*"

Now, with that background of continuous experience in the practical art from 1914 on, note that Mr. Pratt, on cross-examination, said (I, 204):

"I spoke of having seen a great many transmitting stations. *As physical structures, the first ones that I saw that had an antenna in the form of a V with long straight wires, long in terms of wave lengths, and excited in phase opposition, were those which we erected at Sayville.*"

And just before this, on the same page, Mr. Pratt said:

"*The V antennas that I put up at Sayville were the most effective that I knew of at that time,* for the amount of money that I wished to spend on them • • •. To put up one of our double V antennas at Sayville it cost perhaps two to three thousand dollars • • • that is the cost of labor and material."

Mr. Pratt makes no claim to have followed the prior art, or to have *originated* anything, in constructing petitioner's antennas.

The V antennas used by petitioner are described in the stipulated descriptions (Pltf.'s Exhs. 7 to 12, II, 507-529), diagrams being given in each instance. Various dimensional data are set forth in Plaintiff's Exhibit 13 (II, 530-531).

In general, two types of V antennas have been used by petitioner,—single V's and double V's, the former being

bidirective and the latter unidirective. We will describe one antenna of each type.

We have reproduced above (opposite p. 12) the stipulated diagram of *petitioner's single-V antenna No. 2 (original)*. The antenna itself was composed of two long, straight wires, CA and DB, arranged in the form of a V. The other elements shown in the diagram (II, 522) are the "transmitter" or source of electrical oscillations, the transmission line, and the impedance matching circuit. These elements are of no interest now except that they show that the two wires of the antenna were fed in "phase opposition" (see footnote 10, p. 14, above) so that the wires had standing waves of opposite instantaneous polarity thereon (elements of Carter's claim 15 which are admittedly present in all of petitioner's antennas). The angle between each wire of petitioner's antenna No. 2 and the bisector of the angle between them was 17.5°; Carter's formula and curve call for an angle of approximately 17.8° for wires of this length (I, 139). The compass bearing of the bisector of this antenna was N. 49.75° E. (II, 530); in the stipulated data, this is referred to as the "Directivity" of the antenna. This particular antenna was used for communication with, among other places, Vienna, the direction of which is N. 49.74° E. from Sayville, which is substantially that of the bisector.

Petitioner's antenna No. 1 is representative of its *double-V* antennas. The stipulated diagram of that antenna appears in the record at II, 518. There are two V's, one composed of the wires CA and DB, and the other of the wires C′A′ and D′B′,—C′A′ being parallel to CA and D′B′ to DB. By separating the two V's an odd number of quarter wave lengths (three quarters in this case) and feeding the two V's with electrical currents in phase quadrature (90° out of phase), unidirective action is secured,

as explained in the Carter patent; thus the radiation in the direction along the bisector from the apices of the V's toward the open end of the antenna is canceled and the radiation in the opposite direction along the bisector is increased (nearly doubled). The bearing of the bisector ("directivity" of the antenna system) is N. 281.95° E. and the antenna is used for communication with San Francisco, the bearing of which is N. 281.28° E. from Sayville. The angle between the bisector and each wire is 20°,—the Carter formula and curve calling for an angle of about 19.93° for wires of this length (I, 162).

Petitioner's map of its Sayville station[15] shows the lay-out of its various V (and other) antennas. The wire lengths and angles employed in each of petitioner's V antennas are given in the Appendix on the inside of the back cover of this brief.

SUMMARY OF ARGUMENT

For the convenience of the Court, our reply to the defenses raised follows the order of petitioner's argument. It may be summarized as follows:

Point I. The Carter patent is infringed, petitioner's antennas being constructed in accordance with the description in the patent and being covered by claims 15 and 16, here in suit.

Petitioner's contentions that it does not infringe are unsound for the following reasons:

(1) The Carter patent is not limited to antennas which radiate only in the plane of the wires;

(2) Petitioner's antennas all radiate predominantly in the direction of the bisector of the angle of the V;

[15]Plaintiff's Exhibit 23A, II, 622.

(3) The fact that most of petitioner's antennas do not use wires that are an integral number of half wave lengths long does not avoid infringement; and

(4) Petitioner's antennas use the angles specified in the Carter patent.

Point II. The Court of Appeals did not reverse any findings of fact which were made by the District Court on conflicting evidence.

Point III. There was no expansion of the subject-matter of the application for the Carter patent, improper or otherwise.

Point IV. Under the circumstances, no supplemental oath was necessary.

Point V. The Carter patent is valid over the prior art,—in particular, over

(1) The Abraham articles of 1898 and 1901;
(2) The Bethenod French patent No. 596,737;
(3) The Bethenod French patent No. 625,293;
(4) The Levy French patents;
(5) The Lindenblad V antenna patent; and
(6) The prior work of Bruce.

Point VI. Under this heading, we reply to certain specific matters in petitioner's brief. We consider it unnecessary to summarize these points; they are covered by the numbered sub-headings which are also included in the index.

ARGUMENT

POINT I

The Carter Patent is Infringed.

The Carter application as filed, the Institute of Radio Engineers paper, and the Carter patent each described a directive antenna, told how to construct it, suggested (II, 1039; II, 501, lines 58-59; and see II, 605) that it be set up on poles 80 feet high, illustrated it as strung from such poles, and described and illustrated in what direction the antenna would be effective. Petitioner constructed its V antennas, utilizing the co-ordination of wire length, wave length, and angle specified by Carter, set them up on poles 80 feet high (II, 530), and secured antennas that are effective exactly as those that Carter described.[16]

As petitioner says (brief, p. 10), "the present litigation has to do solely with antenna *structure.*" (The emphasis is petitioner's.) Structurally, petitioner's antennas are identical with Carter's and they secure the same results that Carter described,—concentration of radiation in the direction of a distant receiving antenna,[17] simplicity, and

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[16]Direct proof of this is available as to petitioner's antenna No. 1. The directive characteristic of this antenna was measured in the field by Hansell and its directive pattern is given in Plaintiff's Exhibit 24, II, 623. It also follows directly from the testimony of petitioner's Chief Engineer, Pratt, who testified (I, 203):

> "They [the signals] were propagated in the vertical plane containing the bisector of the angle of the wires."

[17]Pratt testified (I, 203-204):

> "I spoke yesterday about changing the direction of some of the antennas at Sayville. By 'changing the directions' I meant the destination to which the signals were intended to go was changed from one place to another. I brought about that change of direction by moving the wires so that they would lie in a different place than they did before. In bringing about this change of direction, the bisector of the angle of the V was changed, of course, when the wires were changed. That was changed from the original destination to the new desired destination, *so that the bisector of angle which formerly bore on one particular point was changed so that the bisector of the angle of the V bore on the new destination.*"

efficiency. They were used to attain those results as well as the highly important result of economy in construction costs. Thus, petitioner's Chief Engineer, Pratt, testified that cost is usually the first consideration (I, 202) and that it cost $2,000 to $3,000 to put up one of petitioner's double-V antennas (I, 204). Equally directive prior structures would have cost upwards of $100,000. (See pp. 7, 9-10, above.)

Claim 15 of the Carter patent reads as follows:

> "An antenna comprising a pair of relatively long conductors disposed with respect to each other at an angle substantially equal to twice $50.9\left(\frac{l}{\lambda}\right)-0.513$ degrees, l being the length of the wire and λ the operating wave length in like units, and means in circuit with said antenna for exciting the conductors in phase opposition whereby standing waves of opposite instantaneous polarity are formed on the conductors throughout their length."

The claim (and the same is true of claim 16, the other claim that is before this Court) describes only structure and says nothing about radiation in the plane of the wires or along the bisector.[17a]

All of petitioner's V antenna wires are "relatively long", being from 4 to 8.14 wave lengths long. The angles used by petitioner in nine of its eleven V antennas are almost exactly the angles determined by the formula set forth in the claim; as to the other two antennas, the angles are sufficiently close to secure predominant radiation in the desired direction, as taught by Carter. (See the stipulated descriptions of the antennas, II, 507-531, and the Appendix on the inside of the back cover of this brief.)

The means recited in the claim,

> "for exciting the conductors in phase opposition whereby standing waves of opposite instantaneous polarity are formed on the conductors throughout their length",

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[17a] As we shall see later, petitioner's antennas radiate exactly as Carter's antenna radiates.

is admittedly present in petitioner's antennas.

This claim accurately defines all of petitioner's V antennas, both single-V and double-V.

Claim 16 differs from claim 15 primarily in calling for

> "a similar parallel pair of conductors spaced an odd number of quarter wave lengths away from said first mentioned pair along the bisector of the angle of the conductors".

This claim also accurately defines all of the petitioner's double-V antennas,—namely, Nos. 1, 4, 5, 6, 7, 8, 9, and 10.

Petitioner's Contentions That It Does Not Infringe the Carter Patent Are Unsound

As we understand petitioner's position, it argues non-infringement on four grounds: (1) that the patent is limited to antennas utilizing the predominant radiation which goes out exactly in the plane of the wires (horizontal plane) to the exclusion of radiation which goes out at small angles above and below that plane; (2) that its antennas do not radiate predominantly in the direction of the bisector; (3) that the patent is limited to antennas the wires of which are an integral number of half waves long; and (4) that the patent is limited to antennas utilizing the exact angle recommended by Carter (not even allowing a variation of as little as 0.02°).[18]

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[18]See the testimony of petitioner's expert, Kelley (I, 309):

> "XQ. 1404. Now, going back to the previous subject, my attention has been called to the fact that you have not said whether *ground effects* and *differences in angle* are the *only* things that might make defendant's antenna operate on a different principle from that taught in the third Carter patent? A. I believe I answered that with a 'yes'.
>
> "XQ. 1405. Those two things are the *only* things? A. *Yes, sir.*"

Note that *petitioner's expert* did not mention the use of wires not an integral number of half waves long as a difference distinguishing petitioner's antennas from the patented structure.

(1) *The Carter patent is not limited to antennas which radiate only in the plane of the wires:*

When an antenna is placed over ground (*e. g.*, on 80-foot poles), the presence of the ground affects the ultimate angle of the predominant radiation in relation to the horizontal plane, *but not its directivity in compass directions* (I, 129). This was known when Carter filed his application and this fact is not denied by petitioner.

The unavoidable effects of the presence of ground are (a) that radiation that leaves the antenna in the exact mathematical plane parallel to the earth (the horizontal plane) is, *at a distance from the antenna,* cancelled by radiation that leaves the antenna at a slight downward angle and is reflected upward from the ground; and (b) that radiation which leaves at a small upward angle is, *at a distance from the antenna,* reinforced by radiation that leaves at a similar downward angle and is reflected from the earth's surface. *The experts are in complete agreement on these points.* (See Hogan, I, 128-129; Kelley, I, 282-283.) These are *inescapable* effects (Kelley, I, 343); they *always* occur when short-wave antennas are placed as both of the parties place them and as they are necessarily placed,—*i. e.*, not far above the surface of the ground. They are collectively called "ground effect".[19] Their joint effect is slightly to elevate or tilt the beam upward, without making any change in its horizontal or compass orientation.

This elevation of the beam, which is only noticeable at a distance from the antenna, does not, as might seem at first glance, destroy the effectiveness of the antenna as a source of signals for a distant receiving sta-

[19]Of course, neither respondent's engineers nor petitioner discovered these ground effects. They have been long known in the art. (See, for instance, Kelley's testimony, I, 252-253, to the effect that the Levy patent of 1925 explained them.)

tion. Long-distance, short-wave transmission, as has long been recognized,[20] is not carried on by means of signals transmitted horizontally along the surface of the earth; the signals that reach a distant receiving antenna are those that have left the transmitting antenna at a small upward angle (possibly 10° above the horizontal) and been deflected back to earth by the so-called "Heaviside layer",—a portion of the upper atmosphere that reflects radio waves due to the fact that it is conductive because of ionization. (See Kelley, I, 209, Q. 295.)

Petitioner's statements (brief, pp. 12-16, 23, etc.) that Carter described his antenna as giving predominant radiation in the plane of the wires can mean no more than that he described the action of his antenna *per se, i. e.*, as though it were located in "free space"—("ground effect neglected", *as Carter himself expressed it* in Figure 7 of his patent). The experts agree that, *neglecting ground effect,* the predominant radiation *is* in the plane of the wires, not only in the case of Carter's antenna but also in the case of petitioner's antennas.[21]

Carter did not think it necessary to analyze or describe in detail the well-known and inevitable effects of ground, and it was not necessary for him to do so (see the cases cited below, at pages 29-31); however, he clearly indicated that he was intentionally omitting such description. It would be as fair to hold a building specification fatally defective because it did not mention the law of gravity, as to treat Carter's disclosure as did the trial court and as petitioner asks that it be treated. And petitioner's argument (brief, p. 24) that it does not infringe because (it says) its an-

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[20]See, for example, Deft.'s Exh. V (II, 789) and Deft.'s Exh. AA (II, 862, 883); see, also, Kelley, I, 251-252.

[21]Carter patent, Fig. 7, II, 494; Hogan, I, 128-129; Kelley, I, 282-283, XQ. 1167; I, 274, XQs. 1090-1; I, 276-277, XQs. 1113-15; Defendant's Exhs. S and T, II, 745, 746; Kelley, I. 275, XQ. 1104.

tennas radiate energy predominantly at a small angle above the plane of the wires, can only mean that it is referring to the radiation that results *at a distance,* due to the inevitable ground effects. Its antennas are exactly the antennas described in Carter's patent and in the paper (Plaintiff's Exhibit 20) published eight months before petitioner's first V antenna was built; in "free space", they would radiate exactly as Carter described (Kelley, I, 274); and over ground, in actual use, the radiation in horizontal or compass directions from petitioner's antennas and that from the antenna described in the patent are identical. As ground effect, in practical use of any fixed antenna, is *inescapable,* the necessary effect of petitioner's argument on this point is that the Carter patent, although describing the *exact structures* that have been adopted and commercially used by respondent's subsidiary and by petitioner, describes an antenna which it is *impossible* to construct (Kelley, I, 274, XQs. 1095-6).

The fact that Carter described the action of his antenna as it would be in "free space",—leaving it to the engineer to determine, if necessary, from knowledge *existing when he filed his application,* what the effects would be of the particular character of ground over which he wished to construct his antenna,—does not limit his patent to antennas located in "free space" and *exclude* antennas located (*in accordance with his recommendations and description*) over the ground (*e. g.,* on 80-foot poles or "about three-quarters of a wave length above ground"—II, 501, lines 54-59).

But even if (as is inconceivable and contrary to the notation on Fig. 7 of the patent) Carter had been ignorant of ground effect, what difference would that make? There was no deficiency in his description of the *structure* of

his antenna. He (like petitioner[22]) was concerned with an antenna which would concentrate the radiation in the direction of a distant receiving station. If one set up an antenna *exactly as described in the Carter patent,* he would not need to know even what the art already knew as to the effect of ground; he would need no information not given in the Carter patent. If he measured the directivity *near the antenna* (as Hansell measured that of petitioner's antenna No. 1[23]), he would obtain a directive pattern like that of Figure 6 of the patent; and the signals received at distant receiving stations would vary in strength according to their direction from the transmitter in accordance with that directive pattern,—the strongest signal being received at stations lying in the direction of the bisector of the angle between the wires.

Also, the distinction between the action of an antenna when ground effect is neglected and normal or "over ground" action is not carried into the claims of the Carter patent. The claims describe antenna *structures* for use wherever and however desired and these structures are used by respondent's subsidiary *and* by petitioner.

That a patentee is not required to write into his specification matters of general knowledge or matters known to those skilled in the art is settled law in this Court. It is equally well settled that if he discloses a practically operative device he need not know the theory of operation, or may be mistaken as to the theory,[24] without prejudice to the validity of his patent.

In *Carnegie Steel Co.* v. *Cambria Iron Co.,* 185 U. S. 403, 437, this Court held:

"The specification of the patent is not addressed to lawyers, or even to the public generally, but to the

[22]See Pratt's testimony quoted in footnote 17, p. 23, above.

[23]See I, 48-50 and Pltf.'s Exh. 24 (II. 623).

[24]There is no mistake in the Carter patent as to theory.

manufacturers of steel, and any description which is sufficient to apprise them in the language of the art of the definite feature of the invention, and to serve as a warning to others of what the patent claims as a monopoly, is sufficiently definite to sustain the patent. *He may assume that what was already known in the art* of manufacturing steel *was known to them,* and, as observed by Mr. Justice BRADLEY, in *Webster Loom Co.* v. *Higgins,* 105 U. S. 580, 586, 26 L. Ed. 1177, 'he may begin at the point where his invention begins, and describe what he has made, that is new, and what it replaces of the old. *That which is common and well known is as if it were written out in the patent and delineated in the drawings.*' "

In *Diamond Rubber Co.* v. *Consolidated Rubber Tire Co.,* 220 U. S. 428, 435-6, this Court said:

"A patentee may be baldly empirical, seeing nothing beyond his experiments and the result; yet if he has added a new and valuable article to the world's utilities, he is entitled to the rank and protection of an inventor. And how can it take from his merit that he may not know all of the forces which he has brought into operation? It is certainly not necessary that he understand or be able to state the scientific principles underlying his invention, and it is immaterial whether he can stand a successful examination as to the speculative ideas involved. [Cases cited.] He must, indeed, make such disclosure and description of his invention that it may be put into practice. In this he must be clear. He must not put forth a puzzle for invention or experiment to solve but *the description is sufficient if those skilled in the art can understand it.* This satisfies the law, which only requires as a condition of its protection that the world be given something new and that the world be taught how to use it. It is no concern of the world whether the principle upon which the new construction acts be obvious or obscure, *so that it inheres in the new construction.*"

As stated by JESSEL, M. R., in *Plimpton* v. *Malcolm*, 3 Ch. Div. 531, at page 568:

> "the specification of a patent is not addressed to people who are ignorant about the subject-matter. It is addressed to people who know something about it."

Of course, in the present case, "ground effect" was well understood by Carter and everybody else skilled in the art and was referred to in the patent by a legend on the *only* figure on which such a reference had any meaning whatever.

The Carter patent must be read in the light of this knowledge of the inescapable effect of ground and, as this Court said in the *Carnegie Steel Co.* case, cited just above, it is as if this knowledge "were written out in the patent".

(2) *Petitioner's antennas all radiate predominantly in the direction of the bisector of the angle of the V:*

Petitioner's second point on the question of infringement (brief, p. 25) is not argued. What petitioner must mean is that, due to ground effect, the radiation from its antennas, which is effective *at a distance,* goes out at an upward angle and hence not on the *mathematical line* of the bisector. Admittedly, however, petitioner's antennas were laid out so that the bisectors of the angles pointed in the direction of the desired receiving station and the radiation goes out from them "in the vertical plane containing the bisector" (Pratt, I, 203),—*i. e.,* in the compass direction in which the bisector points.

(3) *The fact that most of petitioner's antennas do not use wires that are an integral number of half wave lengths long does not avoid infringement:*

Petitioner's argument on this point appears to have two aspects: first, that the patent claims cannot cover

wires which are not an integral number of half wave lengths long because, plaintiff argues (contrary to fact), wires of such intermediate lengths were not disclosed in the application as filed; and, second, that Carter, in distinguishing from the Lindenblad V antenna, limited his own invention to integral half wave length wires.

As to the former, we will show under Point III (which deals specifically with that question) that, contrary to petitioner's position, the original application specifically described the use of wires of lengths *between* integral half wave lengths.

As to the latter aspect of petitioner's argument, it must be borne in mind that the Lindenblad patent failed to disclose, for wires of *any* length, the optimum angle to use between the wires of his V antenna.

What Carter said, when distinguishing his invention from that of the Lindenblad patent during the prosecution of his application, was that Lindenblad did not give "the definite precise *relation* between the angle and the length of the antenna", whereas Carter did. This was expressed in several different ways, as petitioner points out (brief, p. 20). The statement has nothing whatsoever to do with any distinction between integral half wave length wires and wires of other lengths, first because Lindenblad did not give the precise relation for wires of *any* length, and second because Carter *did* give it for wires of *any* finite length and *specifically* (II, 1038, last paragraph) for wire lengths that do *"not correspond to a whole number of half wave lengths."*[25]

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[25]The fact that the wires of four of petitioner's antennas were roughly 7¾ wave lengths long does not indicate any independent development by petitioner; Fig. 38 of plaintiff's Exhibit 20 (II, 585)—published about eight months before petitioner built its V antennas—shows a double-V antenna with wires of that length.

(4) *Petitioner's antennas use the angles specified in the Carter patent:*

Petitioner naïvely states (brief, pp. 19, 25) that none of its antennas "employs the angle called for by the *Abraham* formula." All that petitioner can mean by this is that the Abraham formulas have nothing to do with wires intermediate in length between integral half wave lengths, whereas all but one of petitioner's antennas are intermediate between integral half wave lengths; and that, as to the one remaining antenna, it is eight half wave lengths long and employs an angle between wire and bisector of 22½° instead of the 25° angle recommended by Carter.

Petitioner also argues that its antennas do not employ the Abraham formula "as restated by Carter in empirical form." One fallacy here is that Carter's empirical formula is not a restatement of the Abraham formulas. The Abraham formulas relate only to single wires and, admittedly, are only applicable to them when they are an integral number of half waves long. Even then, the angle of predominant radiation with respect to a wire cannot be directly determined from them. When solved, they give a curve showing the radiation characteristics of a single straight wire in any plane including the wire (Kelley, I, 314, XQ. 1452); to determine the angle, the formula must be maximalized (idem, XQs. 1453-6). Carter's empirical formula, on the other hand, gives, by direct solution, the desired angle and gives it *not only for the limited condition to which the Abraham formulas are applicable* (integral half wave length wires), but also for *all other wire lengths.*

Of course, no different result would be expected from petitioner's insignificant variations from the angles recommended by Carter,—less than ½° in nine out of the eleven

antennas[26] (see Appendix). The largest variation is in antenna No. 8, where an angle of 22½° between bisector and wire was used instead of 25°,—a 10% variation. But in no case did petitioner's angle depart from Carter's (as Lindenblad's did)[27] by so much as to result in predominant radiation in horizontal directions differing from that of the bisector of the angle between the wires, for, admittedly, *all* of petitioner's antennas radiate predominantly in the direction of the bisector (Pratt, I, 203).[28]

As this Court said, on the question of infringement, in *Sanitary Refrigerator Co.* v. *Winters,* 280 U. S. 30, 42:

> "so that if two devices do the same work in substantially the same way, and accomplish substantially the same result, they are the same, even though they differ in name, form, or shape. * * * A close copy which seeks to use the substance of the invention, and, although showing some change in form and position, uses substantially the same devices, performing precisely the same offices with no change in principle, constitutes an infringement. *Ives* v. *Hamilton,* 92 U. S. 426, 430. And even where, in view of the state of the art, the invention must be restricted to the form shown and described by the patentee and cannot be extended to embrace a new form which is a substantial departure therefrom, it is nevertheless infringed by a device in which there is no substantial departure from the description in the patent, but a mere colorable departure therefrom."

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[26]In both of the claims before this Court, the angle is specified as "substantially" that of the empirical formula.

[27]Lindenblad's recommended half angle of just under 6° (which does not vary with wire length or wave length) differs from the optimum angles recommended by Carter, for wires of the lengths suggested by Lindenblad, by from 63 to 75%.

[28]See Pltf.'s Exh. 53 (II, 720) and Deft.'s Ex. CC (II, 897) which show that, using the angle specified in the Lindenblad patent, the predominant radiation goes out in horizontal directions widely separated from that of the bisector. Also, see Kelley, I, 267.

POINT II

The Court of Appeals did not reverse any findings of fact which were made by the District Court on conflicting evidence.

Petitioner seeks to make much of supposed reversals by the Circuit Court of Appeals of Findings of Fact made by the District Court which petitioner says were based on conflicting evidence. This argument is without foundation and cannot stand analysis. The findings which petitioner discusses are all with respect to the *interpretation of written documents* (the Carter patent and his application as filed), and there is no conflict in the testimony, in so far as there is any which bears on these points.

(1) The first findings referred to by petitioner (brief, p. 28) are to the effect that the patent is limited to radiation in the plane of the wires. We have already discussed this subject (pages 26-29, above) and have shown that the experts are in agreement as to the *facts* relating to this subject. The question to be decided is whether or not the patent is to be *interpreted* (in spite of the admitted knowledge of the art) as limited to an antenna that radiates predominantly in the plane of the wires *at all distances and in all positions.*[29]

(2) Petitioner emphasizes the District Court's Finding that petitioner's antenna systems are "radically different" from those of respondent's patents "in structure, principle of operation and instrumentalities". But the evidence on these points was not conflicting.

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[29]This is a question of law. See *Coupe* v. *Royer,* 155 U. S. 565, 579; *Winans* v. *Denmead,* 15 How. 330, 338.

The *structure* of petitioner's antennas and the *instrumentalities* employed were covered by stipulation (see I, 30 and Pltf.'s Exhs. 7 to 13, II, 507-531); as the District Court itself said (II, 1134),

> "*There is no dispute* as to the construction or arrangement of the defendant's antenna systems * * *."

As to the "*principle of operation*" of petitioner's antennas, the experts were again in agreement: see Hogan for respondent (I, 128-129) and Kelley for petitioner (I, 282-283), where he specifically stated that he agreed with Hogan.

The matter that was (and is) in dispute between the parties and the question on which the Court of Appeals differed from the District Court was with respect to *how the Carter patent should be interpreted.*

(3) The third "finding" of the trial court referred to by petitioner (brief, p. 30) is that Carter is confined to a "precise" angle for his V antenna. This also depends upon *interpretation* of the patent and its file history. Consideration of conflicting testimony is not involved.

The trial court's statement that the difference between petitioner's angles and those recommended by Carter "is as great as the difference between Bruce (of the prior art) and Carter" is shown by defendant's Exhibit W (II, 820) to be incorrect;[30] furthermore, Bruce was not "prior art" (see pages 49-51, below).

(4) Petitioner also argues that the Court of Appeals reversed an essential finding of fact made by the trial court on conflicting evidence when it unanimously held

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[30]Two of the antennas shown on Defendant's Exhibit W,—those marked No. 2 and No. 3,—were built *after* this action was instituted; *i. e.*, they are the "rebuilt" antennas of Plaintiff's Exhibit 10. If Exhibit W had shown the *original* antennas Nos. 2 and 3, they would have appeared on the chart exactly on the Carter angle.

(II, 1172) that the original Carter application disclosed the use of wires intermediate in length between integral half wave lengths and the angles to be used for wires of such lengths.

Petitioner seeks to make it appear that there was conflicting testimony as to the interpretation to be placed on Carter's application as filed. But the Carter file wrapper (containing the application as filed, and its history in the Patent Office) was offered in evidence at the close of defendant's case (I, 414) and was never once referred to in the testimony.

As to the trial court's finding that "neither Carter's empirical formula nor Fig. 12 make a correct showing of what happens when the wires are other than exact multiples of half wave lengths", the testimony, when analyzed, does not support it (see footnote 31, page 40, below).

(5) As to the fifth group of findings referred to by petitioner (brief, pp. 32-33),—that no one had ever utilized the subject-matter of respondent's patents,—this, as specifically stated by the District Judge (II, 1156-1157), was based on his interpretation of the patents. Thus what he must have meant was that, on the basis of excluding from the Carter patent antennas located over ground and therefore subject to ground effect, neither party had used the subject-matter of that patent.

POINT III

There was no expansion of the subject-matter of the application for the Carter Patent.

Petitioner argues that the Carter patent is invalid because there was unlawful expansion of the subject-matter of the application. It says that the original application contained no disclosure of the use of antenna wires of

lengths intermediate between integral half wave lengths and that that disclosure was added several years after the application was filed. The District Court sustained petitioner in this argument, but that court clearly must have failed to read the Carter application as filed. On this point, the Court of Appeals specifically found contrary to petitioner's argument, and contrary to the conclusion of the District Court. In its opinion, the Court of Appeals says (II, 1172):

> "Carter's application stated that the invention was applicable to wires of *any finite length*. His *original application* included the empirical formula and the curve of that formula is shown and described.

A comparison of the specification and claims of Carter's application as filed with those of the issued patent will show, without the necessity of argument, that the use of antenna wires intermediate in length between integral half wave lengths was described in the application as filed and that petitioner's position on this point is baseless. For convenience in making such a comparison, we set forth below, in parallel columns, extracts from the Carter application as filed and the corresponding portions of the Carter patent as issued.

Extracts from Carter Application as Filed	Corresponding Extracts from the Carter Patent
"Still a further object of the present invention is to disclose the proper angle for conductors or radiators either an even number of half wave lengths long or an odd number of half wave lengths long, and, in general to disclose the angle for best directional propagation for *wires of any finite length.*" (II, 1032.)	"Another object of the invention is to disclose the angle for the best directional propagation for open-ended *wires of any finite length,* preferably longer than the operating wave length, having standing waves thereon and arranged in the manner proposed." (II, 499, lines 29-34.)
"Figure 12 is a graph showing the proper relationship, according to the present invention,	"Figure 12 is a graph showing the relationship between the length of one of a pair of con-

EXTRACTS FROM CARTER APPLICATION AS FILED (cont.)

between the length of a single conductor of a pair of conductors and the angle to be given it relative to a desired direction of propagation." (II, 1034.)

"**Moreover, it should be clearly understood that the wires of each unit can be of any length whatsoever** provided they are placed at the correct angle for their length. For best tuning, the total over-all length of both of the wires and the 'U' loop terminating them should be effectively an integral number of half wave lengths, but, **the portion forming the radiation element can be of any length.** The law, giving the correct angle for *lengths between odd and even number of half wave lengths, is* not given due to its complexity but, the empirical formula and the curve of figure 12 will be found accurate for all practical purposes, *where the length of wire dealt with does* **not** *correspond to a whole number of half wave lengths.*" (II, 1038.)

CLAIM 19:

"An antenna comprising a pair of relatively long conductors disposed at an angle substantially equal to twice $50.9\left(\frac{l}{\lambda}\right)-0.513$ degrees." (II, 1047.)

CORRESPONDING EXTRACTS FROM THE CARTER PATENT (cont.)

ductors and half the angle between them for obtaining maximum radiation along the bisector of said angle." (II, 499, line 109 to p. 500, line 3.)

"It is to be further understood that the wires of each unit can be *of any desired length* provided they are placed at the correct angle for their particular length. For best tuning, the total over-all length of both of the wires and the U loop terminating them should be effectively an integral number of half wave lengths, although *the portion forming the radiation element can be of any length.* The law giving the correct angle for *lengths between odd and even number of half wave lengths* is not given herein due to its complexity but the empirical formula and the curve of Figure 12 will be found accurate for all practical purposes, *whether or not the length of wire dealt with corresponds to an integral number of half wave lengths.*" (II, 501, lines 8-23.)

CLAIM 15:

"An antenna comprising a pair of relatively long conductors disposed with respect to each other at an angle substantially equal to twice

$$50.9\left(\frac{l}{\lambda}\right)-0.513$$

degrees, l being the length of the wire and λ the operating wave length in like units, and means in circuit with said antenna for exciting the conductors in phase opposition whereby standing waves of opposite instantaneous polarity are formed on the conductors throughout their length." (II, 503.)

Furthermore, both the original application as filed and the patent as issued contain the empirical formula[31] and Figure 12, both of which, as the application as filed specifically stated. "will be found *accurate for all practical purposes, where the length of wire dealt with does not correspond to a whole number of half wave lengths*" (II, 1038).

The Carter application as filed was just as specific as the issued patent in respect to the use of wires not an integral number of half wave lengths long. *If it had issued exactly as filed, it would have described and claimed petitioner's antennas.* Claims 15 and 16, now before this Court, were claims 19 and 20 of the application as filed. Neither those original claims nor the issued claims are limited to

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[31] Petitioner has criticised Carter's empirical formula on the ground that it is an unwarranted extension of the old Abraham formulas. Petitioner's argument is to the effect that the Abraham formulas are valid only with respect to a wire which is an integral number of half wave lengths long; that Carter's formula is derived by interpolation between the points for which the Abraham formulas are valid; and that, therefore, Carter's formula must be wrong. However, petitioner's expert merely said that Carter's formula "doesn't show *exactly* what the curve should be for lengths which are not exact multiples of a half wave length" (I, 238); and he could not say to what extent it was wrong (I, 315) and was not even willing to say that it was in error by as much as one-tenth of a degree. Carter did not say that the formula was rigidly correct but merely that it was "accurate *for all practical purposes*" (II, 1038). Petitioner's expert never denied this; in fact, he could not do so because petitioner's antennas, all but one of which utilize wires intermediate in length between integral half wave lengths, use almost exactly the angle of the Carter empirical formula. As the Court of Appeals stated with respect to petitioner's argument on this point (II, 1172-1173):

> "The effect of this argument is to show that as to wires which are not an integral number of half waves long, the recognition that there was for such wires an angle of predominant radiation was not obvious but was covered by Carter. Carter found that interpolation between these lengths was sufficiently accurate for practical purposes and disclosed the angles to use for V-antennas using wires of intermediate lengths. Appellee [petitioner] followed this disclosure and accomplished the results set forth by Carter."

wires an integral number of half wave lengths long and there is no basis for so limiting them.

POINT IV

Under the circumstances, no supplemental oath was necessary.

Under its Point IV, petitioner argues that, because of the alleged broadening amendment, the patent is invalid because, in its broadened form, it was not subscribed or supported by the oath of the inventor.

But the amendments, as we have shown, were not broadening but were merely clarifying; there was no change of subject-matter. Under such circumstances, no supplemental oath is necessary since the original oath covers the subject-matter of the issued patent.[32]

POINT V

The Carter Patent is valid over the prior art.

The trial court did not mention any of the foreign patents now relied on by petitioner. On the other hand, the Court of Appeals discussed all of them, and held specifically (II, 1175):

> "Critical examination of prior patents and uses finds nothing invalidating the Carter invention * * *."

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[32] *O. K. Jelks & Son* v. *Tom Huston Peanut Co.*, 52 Fed. (2d) 4, 6 (C. C. A., 5th Circ.; cert. denied, 284 U. S. 686); *Richardson Co.* v. *Ruberoid Co.*, 30 Fed. (2d) 232, 234 (C. C. A., 2nd Circ.; L. HAND, *J.*); *Keller Bros. Co.* v. *Crucible Steel Co.*, 297 Fed. 39, 43 (C. C. A., 3rd Circ.; MORRIS, *J.*). See also *De la Vergne Co.* v. *Featherstone*, 147 U. S. 209, 227.

(1) The Abraham Articles of 1898 and 1901

The Abraham articles are mathematical analyses of the radiation from a *single* straight wire in free space. They nowhere suggest any possible utility for the analyses in the construction of a directive antenna, and do not suggest combining two or more wires in any arrangement, or make any analyses of the resultant radiation from any such combination (I, 450-451, Qs. 1001-4).

It is possible to determine, from the formulas given by Abraham, the angle between a single wire an *integral* number of half waves long and the directions of the predominant radiation therefrom, but the formulas as derived by Abraham are not "general" formulas (as petitioner's brief at p. 44 alleges that they are). The Abraham formulas apply only to the special lengths of single wires stated, whereas Carter's empirical formula applies to wires of any length in V formation.

It remained for Carter to conceive of placing two long wires at an angle determined by their length and the wave length used and then to determine the surprising concentration of radiation resulting from a properly arranged V antenna, and to state a formula that would determine the desired angle with accuracy quite sufficient for communication purposes whether or not the length of the antenna wire is made up of exact multiples of half wave lengths of the current.

The holding of the Court of Appeals (II, 1174-5) very clearly and concisely disposes of these articles as a defense:

> "The Abraham articles of 1898 and 1901 with the formula suggested, although 30 years old, had never been utilized. From that time was the entire period of the development of the radio art. While his formulas unquestionably had useful scientific interest to radio

engineers, they failed to teach how to construct a directive antenna. *Nothing in them suggests the inventions of Carter.*"

(2) **The Bethenod French Patent No. 596,737**

This patent discloses an admittedly old type of long-wave antenna,—namely, two horizontal *networks* of wires, one placed above the other, the two being fed in phase opposition. Bethenod's stated invention was the use of this old, long-wave antenna as a short-wave antenna.

Petitioner says that this French patent "discloses a short-wave *directional* system". But all that the *patentee* says is (II, 826) that:

> "Obviously, numerous other variants are *possible*. Particularly the two networks 2 and 3 of Fig. 1 may be arranged vertically or even inclined not only with respect to the ground, but also with respect to one another so as to obtain directional effects either in the horizontal plane, or in the vertical plane, or in both planes."

Both experts agree (Kelley, I, 320; Hogan, I, 445) that this suggestion of Bethenod can be followed and still have all the wires of his antenna system *parallel* to each other. This mere vague suggestion, which taught nothing to the art, is insufficient to invalidate a later patent clearly disclosing a meritorious invention.[33]

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[33]See *Eames* v. *Andrews*, 122 U. S. 40, 66, where this Court said (quoting from *Seymour* v. *Osborne*, 11 Wall. 516, 555):

> "Patented inventions cannot be superseded by the mere introduction of a foreign publication of the kind, though of prior date, unless the description and drawings contain and exhibit a substantial representation of the patented improvement, in such full, clear, and exact terms as to enable any person skilled in the art or science to which it appertains, to make, construct, and practice the invention to the same practical extent as they would be enabled to do if the information was derived from a prior patent.

(*Footnote continued on next page*)

Bethenod also fails to disclose the Carter invention because he does not disclose *long* wires (I, 444) and because his antenna system is composed of *networks* of wires rather than of simple, straight wires.

Petitioner finds Carter's invention in this Bethenod patent because (petitioner says) "the angle must be chosen in accordance with the well-known Abraham formula to insure best radiation in the desired direction", stating then that one skilled in the art "would obviously employ it". (Brief, p. 44.) With this latter statement we most emphatically disagree. It is supported solely by the testimony of petitioner's expert; on the other side of the scale, there is the testimony of *petitioner's* witness Bruce, who admittedly was "one skilled in the art". He had a form of V antenna in May, 1926 (II, 907), was acquainted with the Abraham or equivalent formulas (I, 366-367), and failed to see that one could be used in connection with the design of the other until 1930,—*after* the Carter invention had been made. The testimony of this highly skilled, practical worker in the art—binding, as it is, on petitioner—far outweighs the largely argumentative testimony of its expert, who was primarily versed in theory (I, 268-269).

(3) The Bethenod French Patent No. 625,293

It is only necessary to examine the drawing of this patent (II, 830) to see that it has no bearing on the Carter invention. The patent discloses a *single-wire* antenna. The novelty of the arrangement is in the feed-system, not in the antenna. *Bethenod does not state or suggest that the antenna that he shows is directive;* he merely says that direc-

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Mere vague and general representations will not support such a defence, as the knowledge supposed to be derived from the publication must be sufficient to enable those skilled in the art or science to understand the nature and operation of the invention, and to carry it into practical use."

tivity can be secured by the use of *several* separate antennas of the same kind, suitably positioned in reference to one another (I, 450).

(4) The Levy French Patents

Petitioner's statements (brief, pp. 45-6) that the teaching of these patents is "in all essential respects, the same as petitioner's antennas" and that Levy "explains the directional radiation that is obtained from petitioner's antennas" can only mean that Levy explains the effect of ground in canceling, at a distance, the horizontal radiation and augmenting the tilted radiation.

Petitioner says that certain quoted portions of the Levy patent contain "a complete definition of the directional radiation that is obtained from petitioner's antennas". Levy here says that the predominant radiation from his antenna is in "the vertical plane *perpendicular to the axis* of the radiator". This is not true of the antenna of the Carter patent, or of respondent's or petitioner's antenna structures; all of them radiate predominantly in the vertical plane which *includes* the axis of the radiator system.

Furthermore, Levy's wires were *short*,[84] and he failed to appreciate or suggest any advantage in the use of long wires, which constitute the fundamental antenna units of the Carter antenna.

Also, he showed *networks, each composed of three wires;* the radiation from such networks would be uncertain because the phasing and the relative position of the wires are not definite (I, 440-441).

Like Bethenod, Levy is *totally indefinite as to the obtaining of directive action* with his antenna. All he says (II, 867) is:

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[84]The wires are only a quarter of a wave length long (Hogan, I 440; Kelley, I, 253, 329).

> "In the first place, it is desirable to point out that *it is possible,* instead of adopting the arrangements described in the main patent, *to conceive of* different variations which may offer advantages in certain cases, particularly where it is desired to radiate energy in a given direction."

And, of course, Levy does not disclose or suggest the relation taught by Carter, or *any* relation, between wire length, wave length, and angle. As a matter of fact, the best directivity (such as it is) obtainable with Levy's antenna is obtained when his two networks are arranged end to end and in a straight line,—in which case they become similar to the simple dipole antenna,[35] which was much discussed in the record and was a well known antenna in the prior art (I, 73-75, 81).

(5) The Lindenblad V Antenna Patent

Petitioner argues (brief, p. 47) that "the art knew that the wires of the [Lindenblad V] antenna *must* be arranged in accordance with the Abraham formula for best radiation" (emphasis is petitioner's). The proofs are to the contrary. For example, Bruce, a skilled worker in the art, who knew of the Abraham formulas, and experimented with V antennas, showed no appreciation of what petitioner now says was known in the art. (See our discussion of Bruce's work at p. 44, above and pp. 49-51, below.)

This argument of petitioner that there was no invention in what Carter did over Lindenblad is one frequently met in patent cases. As this Court said in *Diamond Rubber Co.* v. *Consolidated Rubber Tire Co.,* 220 U. S. 428, at page 435:

> "*Knowledge after the event is always easy,* and problems once solved present no difficulties, indeed, may be represented as never having had any, and expert witnesses may be brought forward to show that

[35] See Pltf.'s Exh. 51, II, 715; Hogan, I, 441-442.

> the new thing which seemed to have eluded the search of the world was always ready at hand and easy to be seen by a merely skilful attention. But the law has other tests of the invention than subtle conjectures of what might have been seen and yet was not. It regards a change as evidence of novelty, the acceptance and utility of change as a further evidence, even as demonstration."

As we have pointed out, Lindenblad did not consider the angle between the wires to be of importance. Thus he said in his patent (II, 488, lines 115-119):

> "The divergence [between the wires] should preferably be *fairly gradual,* and the spacing at the open end, while variable over a great range, should be in the neighborhood of a fifth of the length"—

which means an angle of about 12°, regardless of wire length and wave length (I, 451). The wire lengths suggested by Lindenblad are "of the order of magnitude of five to ten waves long" (II, 488, lines 120-121). The optimum angles between wires of these lengths, as taught by Carter, vary from 45° to 32°.

Carter's file history does not support petitioner's statement that Carter's invention consisted solely in the application of the old Abraham formula to determine the precise angle of the Lindenblad V antenna. Carter determined, as we have pointed out before, the proper *co-ordination of wave length, wire length, and angle for securing optimum directivity from a V-type antenna.* He further determined the formula that correctly states the relation between these three variables for securing maximum results regardless of wire length and of wave length.[36] If any one of these

[36]Admittedly, the prior art, Abraham, single-wire formulas taught nothing whatsoever about radiation from wires not an integral number of half waves long; for wires of those lengths, there *was* no Abraham formula,—nor any other knowledge as to how such wires radiated or even that there were predominant directions of radiation from such wires. (See page 33, above.)

variables is changed, one or both of the others must be changed to maintain optimum results. Neither Lindenblad nor any of the alleged users of V antennas had any conception whatever that any such co-ordination was necessary or even beneficial or indeed any idea of a co-ordination.[37]

That Carter obtained a new result, as compared to what Lindenblad had done, is shown by Defendant's Exhibits CC and DD (II, 897, 898). These are plots of the radiation from antennas described by Lindenblad and show that the predominant radiation does not go out on the bisector of the angle between the wires but in directions widely departing therefrom.[38] Respondent's Exhibit 53 compares the radiation from a "Lindenblad V antenna" (II, 720) with that from a Carter two-wire V antenna (II, 722), with the same power input and on the same scale (I, 453). The difference is striking.

The opinion of the Court of Appeals concisely distinguishes the disclosure of the Lindenblad patent from the Carter invention. It says (II, 1169):

> "*Lindenblad stated nothing* as to the advantages of any specific angle between the wires of his V-antenna and as to *any relation between preferred angle, wire*

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[37]The Lindenblad patent was cited by the Patent Office as a reference against Carter (II, 1090) but was eventually withdrawn. Under such circumstances, the *prima facie* validity of the Carter patent is greatly strengthened. *Gairing Tool Co.* v. *Eclipse Co.*, 48 Fed. (2d) 73, 75 (C. C. A., 6th Circ.); *Artcraft Silk Hosiery Mills* v. *Gotham Co.*, 72 Fed. (2d) 47, 48 (C. C. A., 3rd Circ.; certiorari denied, 293 U. S. 595); *Stevens* v. *Carl Schmid, Inc.*, 73 Fed. (2d) 54, 56 (C. C. A., 2nd Circ.; certiorari denied, 294 U. S. 721); *Chesapeake & O. Ry. Co.* v. *Kaltenbach*, 95 Fed. (2d) 801, 804 (C. C. A., 4th Circ.).

[38]As petitioner's expert said, referring to Lindenblad's antennas (I, 267):

> "not only does predominant radiation not take place along the axis [bisector] of the conductor system, but the predominant radiation is in the directions which lie wholly outside of the wires forming the system."

length, and wave length. He said that the spacing between the ends of the wires, 'while variable' over a long range, should be in the neighborhood of a fifth of the length *which, regardless of wave lengths and wire lengths,* means an angle under 12° between the wires. The wire length suggested is of the order of five or ten waves long. *Carter* taught 12° is not the most desirable angle for a V-antenna having wires of these lengths. He developed the theory of long wire V-antennas and taught how to construct them so as to secure maximum directivity by *co-ordinating the angle, wire length, and wave length.*"

(6) The Prior Work of Bruce

Petitioner appears to have abandoned Bruce as a prior inventor of the subject-matter of the Carter patent. (See its brief, pp. 47-8.) The reason becomes apparent when the true effect of Bruce's testimony is appreciated.

Bruce was a skilled worker in the art, a graduate electrical engineer, to whom outstanding honors have been awarded for his work in short-wave, directional antenna development (I, 376-377). He commenced his research work in this field in 1924 (I, 352) and, over the next six years, he carried on "a vast amount of work" (I, 367, 373-375, 377, 381, 398-399), practically all for the purpose of developing a directive antenna (I, 353). This work was all done for the American Telephone and Telegraph Company (I, 377).

Before commencing his work, Bruce familiarized himself with the literature on the subject (I, 353, 378) and was familiar, at least as early as 1926, with the Abraham formulas as set forth in the Levin and Young article (I, 366-367, 381; II, 903).

In May, 1926, he tested an antenna composed of two long wires, one horizontal and the other inclined upward from it in the same vertical plane,—*i. e.*, having the form of

a V (II, 907). The angle between the wires (as may be computed from the constants given) was 9½°,—even smaller than the angle suggested by Lindenblad. The correct angle, as determined from Figure 12 of the Carter patent, would have been 68°.

These experiments of May, 1926, are significant. They show that Bruce had, as early as 1926, experimented with an antenna composed of a pair of simple, straight, long wires arranged in a common plane. Although he erected and tried out such an antenna, *he totally failed to appreciate the possibilities of a V antenna* with proper co-ordination of wire length, wave length, and angle between the wires. *Instead, he turned away from the simple, two-wire V arrangement and never returned to it.* He went to single tilted wires (either straight, or bent in the middle to form an *inverted* V, fed at one end; Bruce, I, 380, 387) and *four years later, in 1930, after* Carter had invented the subject-matter of his patent,[39] devised his *first* commercially successful antenna,—the horizontal *rhombic* (diamond) antenna of his British patent No. 392,201 (Pltf.'s Exh. 41, II, 634-637).

In most patent cases, the Court can do little more than guess, on the basis of conflicting expert testimony, what the mythical "man skilled in the art" would have done with the prior art in front of him. But in the present case, petitioner's own testimony (that of Bruce and his co-workers) shows affirmatively what a man *highly* skilled in the art and working on the identical problem that the patentee was working on was able—or, rather, *un*able—to do, with the prior art (as represented by the literature and by his own

[39]Prior to March, 1930, Carter had conceived of, disclosed to others, built, and tested his V antenna; and commercial adoption followed quickly (*I*, 421-438). Petitioner has never questioned the adequacy of this proof.

work) before him. And the history of what the art actually did in commercial practice (set forth at pp. 6-9, above) supports our contention that Carter, when he invented the V antenna of his patent, accomplished something of real novelty and utility: the history of the art is entirely inconsistent with petitioner's position that the invention was obvious. The evidence in the present case on the question of invention is of the kind that is most satisfactory and convincing.[40]

POINT VI

Reply to other specific matters in petitioner's brief.

(1) *Carter's suggestion of tilting his antenna does not indicate that he expected predominant radiation, at all distances, in the plane of the wires:*

Petitioner argues (brief, p. 13) that the Carter patent "states (Vol. II, p. 502, ll. 27 *et seq.*) that when it is desired to radiate *at an angle* to the earth's surface it is necessary to tilt the wires from their *normal horizontal position* to the *required angle to the earth,*" etc. (Emphasis is petitioner's.)

But this is *not* what the patent says. It merely says that "it may often be found desirable" to tilt the antenna "*towards* the *direction* in which the beam of energy is to be propagated." Carter says, in effect, that it may be desirable to have the radiation go out at a higher angle than will result from a horizontal antenna; that, under those circumstances, the antenna should be tilted "*when* it is desired to radiate at an angle to the earth". The ac-

[40] See *Eibel Process Co.* v. *Minnesota, etc., Paper Co.*, 261 U. S. 45, 63; *Carnegie Steel Co.* v. *Cambria Iron Co.*, 185 U. S. 403, 429-430, 446.

curacy of Carter's teaching in this respect is not questioned (I, 343, XQ. 1755).

(2) *There is no "admission" in Carter patent No. 2,027,020 that the patent in suit is limited to radiation in the plane of the wires:*

Petitioner argues (brief, pp. 13-14) that a *later* Carter patent constitutes an admission that the patent in suit was intentionally and deliberately limited to radiation in the plane of the wires. However, all that the later patent says is that, as we admit, the patent before this Court does not *describe* the well-known effects of ground.

Furthermore, as was held in *Deitel* v. *Unique Specialty Corp.*, 54 F. (2d) 359, 360 (C. C. A., 2nd Circ.), with respect to statements made by a patentee in a later filed application:

> "We cannot regard either the patent or what he said as material to the proper interpretation of the claims in suit. *At most they could be regarded as no more than admissions, and as such they were not material to the construction of the patent in suit,* a formal written instrument, whose meaning we must find from its terms."

(3) ***What Carter invented was an antenna, not a formula:***

Petitioner (brief, p. 17) says that we have

> "conceded • • • that there was no element of novelty or invention in the utilization of the Abraham formula, and advanced the *empirical* statement of the Abraham formula as Carter's invention." (Emphasis is petitioner's.)

This is a gross misstatement of our position. We have *always* asserted that what Carter invented was an *antenna.*

He merely utilized the Abraham formulas in mathematically analyzing and explaining a theory of results he got from his new structure. Carter did not patent or attempt to patent any formula.

(4) *Petitioner's Exhibit X does not show that Carter's empirical formula is incorrect:*

Petitioner says (brief, p. 22) that its Exhibit X (II, 821) "graphically illustrates" that Carter's empirical formula is not valid. Lest the Court be misled by the appearance of the curve of this exhibit, we wish to point out that Exhibit X [illegible] curve of "radiation resistance" in relation to wire length. But radiation resistance is one thing and angle of predominant radiation is another thing. Petitioner's expert discussed the radiation resistance curve *not,* as petitioner has said, to demonstrate that Carter's empirical formula was incorrect, but to show some supposed advantage in petitioner's use of wires an odd number of quarter wave lengths long (I, 239-244). Kelley never said that the radiation resistance curves showed that Carter's empirical formula for the *angle* was incorrect.

(5) *Petitioner does not employ old V-Type Antenna Structures:*

Petitioner states (brief, p. 23) that it

"employs the *old* V-type antenna structures."

However, petitioner has combed the art and it has been unable to show a single description of a V antenna employing the co-ordination of elements taught by Carter. In this connection, we note petitioner's statement (brief, p. 11) that:

"the art prior to the Carter patent in suit disclosed *a multitude of types and arrangements of antenna*

> *wires,* singly or in multiples, alone or with reflector, vertically, horizontally or angularly arranged towards the earth or towards each other."

This may be true, but petitioner's failure to use any of these prior antennas and its adoption of the Carter antenna just as described in plaintiff's Exhibit 20, in the Carter application as filed, and, later, in the Carter patent, speaks eloquently of the novelty and utility of Carter's invention.

(6) *There is no evidence that petitioner "intentionally" or "deliberately" sought to obtain a different result in constructing its antennas:*

At page 24 and elsewhere in its brief, petitioner refers to the testimony of its expert Kelley to show that, in constructing its antennas, certain results were sought *"intentionally"* and *"deliberately"* (emphasis is petitioner's). Although Kelley made such statements on his direct examination, on cross-examination he repeatedly disavowed any knowledge as to why petitioner's antennas were built as they were (I, 269-270, 273); he said (XQ. 1067):

> "I have no knowledge of when they were designed, who did it, or what they did. I have only seen them as they exist."

Petitioner's Chief Engineer, Pratt, under whose direction petitioner's antennas were designed and installed (I. 201, 204), also testified for petitioner. If petitioner constructed its antennas in any special way to secure any special results other than those taught by Carter, Pratt was the only witness competent to testify to that fact. He was not asked for any such testimony, and gave none.

(7) *The Carter patent is not a "paper" patent:*

At several places in its brief (*e. g.*, pp. 26, 52), petitioner refers to the Carter patent as a "paper" patent, as one "unused by anyone", etc. We have shown that not only respondent, but also petitioner, *has employed the exact structure described in the patent.* The record shows petitioner had erected eleven such antennas (II, 622), and respondent forty (I, 44) at the time of the trial.

(8) *Adamson* v. *Gilliland does not apply:*

Petitioner (brief, p. 27) refers to the decision of this Court in *Adamson* v. *Gilliland,* 242 U. S. 350, as showing that the Circuit Court of Appeals was in error in reversing the District Court. We have shown, however, that the "findings" of the trial court were chiefly *interpretations* of written documents or based upon such interpretations, and that they do not depend upon conflicting testimony or upon the credibility of witnesses. Under such circumstances, they do not have the weight ordinarily attaching to findings of fact. *Morimura, Arai & Co.* v. *Taback,* 279 U. S. 24, 33.

(9) *The number of witnesses:*

As to petitioner's intimation (brief, p. 28) that the trial court had to resolve conflicts involved in the testimony of "more than a score of witnesses", we note, first, that only fifteen witnesses testified and, second, that, of these, nine testified solely with respect to Bruce's alleged prior invention or Carter's date of invention, four testified solely with respect to facts as to which there was no conflict, and only with respect to the testimony of the remaining two (the experts, Hogan and Kelley) could there be said to be any conflict. The experts were in agreement as to

substantially everything except the *interpretation* of the patent and the pertinency of certain prior art.

We definitely dispute the assertions of petitioner set forth in the last paragraph on page 33 of its brief. As to the more important "findings" of the trial judge, we submit there is *no* competent testimony consistent therewith.

(10) *The art's knowledge of "Reflector Effect" does not affect the validity of the Carter patent:*

At pages 40-42 of its brief, petitioner goes to great pains to show that, as has never been questioned by us, the so-called "reflector effect" was known before Carter invented his V antenna. Petitioner's argument appears to be that claim 16 of the Carter patent covers the combination of his new V antenna with a prior art "reflector" and that the claim is therefore invalid, citing the decisions of this Court in *Lincoln Engineering Co.* v. *Stewart-Warner,* 303 U. S. 545, and *Powers-Kennedy Contracting Corp.* v. *Concrete M. & C. Co.,* 282 U. S. 175. However, neither of these decisions is applicable to the present case.

There is no prior art element in Carter's claim 16. What the claim covers is two of his *new* V antennas, properly spaced with respect to each other to secure unidirective action. The combination claimed, both in its entirety and in its component parts, is a *new combination.*

The type of claim criticized in the *Lincoln Engineering* case was one which sought to cover an *old combination,* one element of which had been improved. The reason why such a claim is void is that the patentee thereby seeks,

> "by the use of a combination claim, to *extend the monopoly* of his invention of an improved form of chuck or coupler *to old parts or elements* having no new function when operated in connection with the coupler • • •." (Page 552.)

Carter's claim 16 cannot extend his monopoly because each of the elements of the claim is separately covered by, for example, claim 15.

In the *Powers-Kennedy* case, the claim under consideration was held invalid because

> "It consists of a combination of elements *all of which were old in the art.* * * * Neither the combination of *old elements or devices* accomplishing no more than an aggregate of old results [cases cited] nor the use of an *old apparatus or appliance* for a new purpose [case cited] is invention." (Page 186.)

All of the elements of Carter's claim 16 (namely, two of his new V antennas) were new with him; therefore, the holding of this Court in the *Powers-Kennedy* case also has no application to the present case. The subject-matter of claim 16 is a new antenna, not an old combination.

CONCLUSION

The accused antennas of petitioner are identical in structure, position, and actual effectiveness in use with antennas described in the Carter patent in suit. The trial court's decision of non-infringement was based on its interpretation of the patent in suit as being limited to a V antenna which, under all conditions and at all distances, concentrates radiation in the plane of the wires and on the bisector of the angle of the V, and upon its interpretation of Carter's application as filed.

The trial court did not find the Carter patent anticipated by any of the prior art, or invalid thereover. The Court of Appeals specifically held that the prior art does not anticipate. It also specifically held that the trial court's reading of the Patent Office history of Carter's application, resulting in a conclusion that there had been an improper expansion of the disclosure by amendment, was erroneous.

When the Carter patent and the original application therefor are correctly interpreted, the basis for the trial court's decision entirely vanishes. The errors of that court were mistakes of interpretation of documents and were corrected on appeal. That being so, and it having been shown in addition that the history of this patent in the art demonstrates that an invention of high order was made, we think the statement of the Court of Appeals, in concluding its opinion, is an apt conclusion for this brief. That Court said (II, 1175):

> "The problem solved here was of long standing and it was an eminently successful solution. Critical examination of prior patents and uses finds nothing invalidating the Carter invention and it shows a substantial accomplishment."

The decision of the Circuit Court of Appeals for the Second Circuit should be affirmed.

Dated, December 5, 1938.

Respectfully submitted,

Jo. Baily Brown,
Abel E. Blackmar, Jr.,
Harry Tunick,
Counsel for Respondent.

APPENDIX.

Angles Utilized in Petitioner's V Antennas Compared to Angles Recommended by Carter.

Petitioner's Antenna No.	Wire Length in Wave Lengths	Angle Between Wire and Bisector—*as used by Petitioner*	*as Recommended by Carter*	Difference
	(II, 530)	(II, 530)		
1 (double V)	6.21	20°	19.93° (I, 162)	+0.07°
2* (single V)	7.74	17.5°	17.8° (I, 139)	—0.3°
3* (single V)	7.69	17.86°	17.88° (I, 160)	—0.02°
4 (double V)	7.69	17.5°	17.88° (I, 162)	—0.38°
5 (double V)	6.21	20°	19.93° (I, 162)	+0.07°
6 (double V)	7.67	17.5°	17.9° (I, 162)	—0.4°
7 (double V)	6.24	20°	19.88° (I, 162)	+0.12°
8 (double V)	4.	22.5°	25° (I, 151)	—2.5°
9 (double V)	7.70	17.5°	17.86° (I, 162)	—0.36°
10 (double V)	7.17	17.5°	18.53° (I, 162)	—1.03°
11 (single V)	7.69	17.5°	17.88° (I, 160)	—0.38°

*Antennas Nos. 2 and 3 above referred to are those antennas in their original form.